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ABSTRACT

A plan at Purdue University to develop a model program for women in engineering is described. The Purdue Department of Freshman Engineering received a grant from the U.S. Department of Education through the Women's Education Equity Act to help overcome some of the problems faced by women who enter engineering. The program focuses on an experimental course that provides beginning engineering women and men with: (1) hands-on laboratory experience; (2) discussions by various role model lecturers of contemporary societal problems, including environment, energy and productivity; and (3) career planning sessions. Pre- and post-testing with standardized tests and specially developed surveys used to evaluate experimental and control groups demonstrated positive effects of the program. (Author/BH)

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AN ACTION RESEARCH PROPOSAL TO PROVIDE EDUCATIONAL EQUITY, OPPORTUNITIES FOR WOMEN IN ENGINEERING

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Abstract

The Purdue University Department of Freshman Engineering received a grant from the U.S. Department of Education through the Women's Educational Equity Act. The Purdue program is designed to develop a model program for women in engineering. The program focuses on an experimental course which provides beginning engineering women and men with (1) hands-on laboratory experience; (2) discussions by various role model lecturers of contemporary societal problems, including environment, energy and productivity; and (3) career planning sessions including the use of the Purdue Interest Questionnaire and the Strong-Campbell Interest Inventory. Pre- and post-testing with standardized tests and specially developed surveys were used to evaluate experimental and control groups with generally positive results.

Plans are now being made to revise the experimental course and to incorporate changes based upon student and staff observations and upon evaluation data. Dissemination efforts will include an invitational workshop, professional papers, media releases, and wide distribution of the final report.

Introduction

It has been found that women who enter non-traditional fields in college, such as science and engineering, tend to face a variety of problems with which men in these fields are not confronted. Many of these problems occur due to the lack of equal technical-educational opportunities that are not available to the majority of women, including those who enter engineering.[1] This frequenly results in lower self-confidence in their technical and mechanical abilities[2,3] than men who enter engineering and contributes to their uncertainty regarding their choice of engineering as a career and in their choice of a particular field within engineering. This uncertainty is also due to the fact that women who enter engineering are more likely to make their decision much later during their career than men.[4,5] It was felt a program designed to remedy these problems, which women entering engineering often face, could be developed to include both the problem of technical and mechanical abilities and the problem of career indecision for women in engineering.

A grant from the U.S. Department of HEW, Office of Education, through the Women's Educational Equity Act, has provided funds for the Department of Freshman Engineering at Purdue University to design a model program to help overcome some of the problems faced by women who enter engineering. Purdue's model program, an experimental course-Engineering 195, Engineering, Skills and Career Planning, consists of three areas of emphasis: (1) role model lecture-discussions, (2) hands-on laboratories, and (3) career counseling. The Purdue engineering program was modeled in part on other programs for women in non-traditional fields. One such program, "New Avenues for Women in Physics" at the University of Oklahoma consists of two introductory physics courses, one per semester, especially designed for women. Included in the course were role model speakers, basic laboratory experiences related to physics and one session each week during which students speak freely about the program with a clinical psychologist. The program was later modified to include both men and women. Another program involving the development of basic engineering laboratory skills took place at Cornell University.[6] The laboratory sessions were later modularized and integrated into Cornell's curriculum. Another program for women in science was initiated by Purdue University's School of Science.[7] It consisted of intensive career counseling, a three credit hour pass/non-pass course by role model lecturers with an approximately equal amount of time for each science area and faculty-student research projects. Opinion varies regarding the pros and cons of providing mixed or women only laboratories. At Cornell the women students felt the course should be open to men, but there should be separate sections. At Oklahoma they indicated that "Actually there is nothing on paper to indicate any detrimental affect of mixing men and women. ...However there is a very great difference in the spirit of the program and it seems to be correlated with intensity of psychological counseling, total number of girls, and sexual segregation."[8]

Purdue's Freshman Engineering program integrates three areas: laboratories, role model lecture-discussions, and career counseling into a single course designed specifically for freshman women in engineering. The hands-on laboratories are similar to Cornell's and Oklahoma's program; the role model lecture-discussions are similar to

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Oklahoma's Physics and Purdue's School of Science programs; and the career counseling is similar to Purdue's School of Science Department program. Another feature of the Purdue program is to examine the relative effectiveness of laboratories for "women only" or "mixed" laboratories. If the model program appears to be successful at Purdue, it is hoped that it can be used by other engineering institutions for women engineering students.

Method

Subjects. During the fall semester of 1976, about 2000 freshman engineering students at Purdue were given information about the experimental course to be offered during the spring semester of 1977. Approximately 250 students expressed an interest in the course, approximately 75 women (30%) and 175 men (15%). From the 250 students, names were randomly assigned according to sex to two experimental groups and two control groups. The two experimental groups consisted of a group of 30 women and a group of 15 men and 15 women. The control groups included one group of 25 women and one group of 30 men. However, after the scheduling for the second semester was completed, several changes had to be made. Some students had conflicts in their schedules and could not take the course. Some students from the control group and from outside both the control group and experimental group were allowed to sign up for Engineering 195 in order to fill the class.

Fifty-two second semester freshman engineering students enrolled in the course, 37 women and 15 men. The two experimental groups consist of a group of 22 women and 4 men, and a group of 15 women and 11 men. Control subjects were obtained by sending students from the original control group along with those people who were originally assigned to the experimental group, but did not actually sign up for the course, a letter offering to pay them $5 to complete the pre-testing and $10 to complete the post-testing. Fifteen students from the initial control group, 10 women and 5 men, actually completed both sets of tests. Because the staff feared this group would be too small, an additional back-up control group of 65 second semester freshman engineering students, 61 men and 4 women, registered in a general freshman engineering design course participated in the pre- and post-testing and surveys.

Procedure. *Engineering 195*, Engineering, Skills and Career Planning was offered as the experimental course and as a two semester hour course during the spring semester of 1977. The primary purpose for offering the course was to field test the model program and the educational materials developed.

The course consisted of a one hour lecture-discussion session and a two hour laboratory session each week. The lecture-discussion sessions were common to all 52 students who enrolled in the course, but the laboratory was divided into two sections, one consisting primarily of women and the other consisting nearly equally of men and women. The two laboratory sections, called 195A and 195B respectively, were considered as separate groups for some of the statistical analyses, since they differ by sex in composition, but were considered as one group for most of the statistical analyses.

The experimental course had three primary areas of emphasis: the role model lecture-discussions, the hands-on laboratories, and the career counseling. Table 1 gives the course assignments for the semester.

The Role Model Lecture-Discussions. The role model lecture-discussions, which took place during the one hour lecture each week, provided a variety of role models from fields within engineering as well as from fields outside of engineering, concerned with current engineering problems. The primary purpose of the role model lecture-discussions was to give students a better idea of the variety of problems engineers commonly deal with and what their work ordinarily involves. Problems

Figure 1. Gwendolyn Albert of the U.S. Environmental Protection Agency discusses water pollution problems in Texas.

discussed by the role models were related to the areas of energy, the environment, transportation, productivity, and biomedicine. Table 2 contains a listing of the role model speakers, their affiliation, and the topics they discussed. By choosing speakers outside of engineering as well, the relationship of engineering to a variety of occupations was shown. Role models were also chosen from a variety of backgrounds, including both minority and majority group members, men and women, young and old, and single and married people employed by government, industry, or the university.

The Hands-On Laboratories. The hands-on laboratories were planned to familiarize freshmen engineering women and men, with basic engineering tools and equipment which are the basic building blocks of modern engineering design and production. The laboratory was also designed to help increase womens' confidence and understanding of engineering by developing basic technical skills which many of them did not have prior to entering college.

TABLE 1, ENGR. 195 A,B - ENGINEERING SKILLS & CAREER PLANNING LESSON ASSIGNMENT SHEET

Date	Lesson No.			TOPIC	READING ASSIGNMENT
	Counseling and Testing	Lectures	Laboratories		
Jan. 11	1			Introduction	
11,13	2			Initial Testing	
18		3		Lecture #1: Career Planning I	
18,20			4	Lab. #1: Hand Tools	
25		5		Lecture #2: "The Environment"	G&H* Chapter 5 (Scan)
25,27			6	Lab #2: Power Hand Tools	
Feb. 1		7		Lecture #3: "The Environment"	
1,3			8	Lab #3: Power Tools	
8		9		Lecture #4: "Energy"	G&H Chapter 4 (Read)
8,10			10	Lab #4: Woodwork	
15		11		Lecture #5: "Energy"	Read "Energy Handout"
15,17			12	Lab #5: Electricity	
22		13		Lecture #6: "Energy"	
22,24			14	Lab #6: Plumbing	
Mar. 1		15		Lecture #7: "Transportation"	G&H Chapter 3 (Read)
1,3	16			Career Planning II (Lab.),Test #1	
15		17		Lecture #8: "Transportation"	
15,17			18	Lab #7: Intro. to Recip. Eng.	
22		19		Lecture #9: "Bio-Medical"	G&H Chapter 10(Scan)
22,24			20	Lab #8: Small Engines	
29		21		Lecture 10: Career Planning III	
29,31			22	Lab #9: Intro. to Automotives	
Apr. 5		23		Lecture #11: "Bio-Medical"	
5,7			24	Lab #10: Auto Safety Inspection	
12		25		Lecture #12: "Productivity"	
12,14			26	Lab #11: Auto Tune-up	
19		27		Lecture #13: "Productivity "	
19,21			28	Lab #12: Turbine Engines	*Glorioso and Hill, Introduction to Engineering.
26	29			Test #2	
26,28	30			Final Testing and Course Wrap-up	

TABLE 2, ENGR. 195 A - LECTURE SCHEDULE

Topic	Speaker	Organization
Career Planning I	Christine Smith	Freshman Engineering, Purdue
Environment	Lorel Au	Eastman Kodak
	Gwendolyn Albert	Environmental Protection Agency
Environment	Ron Wukash	Civil Engineering, Purdue
Energy	Gerry Heydt	Electrical Engineering, Purdue
Energy	R. E. Bailey	Nuclear Engineering, Purdue
Energy	Keith Brown	Management, Purdue
Transportation	Ann Muzyka	U.S. Dept. of Transportation
Transportation	Alan McDonald	Mechanical Engineering, Purdue
	Raymond Goodson	Mechanical Engineering, Purdue
Biomedicine	Dianne Rekow	Medtronic, Inc.
Engr. Careers and Current Issues	Blaine Butler	Freshman Engineering, Purdue
Biomedicine	Leslie Geddes	Biomedical Engineering, Purdue
Productivity	Fred Wood	F-16 Project Office, Wright-Patterson AFB
Productivity	Harold Amrine	Industrial Engineering, Purdue
Career Planning II	Christine Smith	Freshman Engineering, Purdue

Figure 2. Professor Hoover shows Engr. 195 students the procedure for threading a metal pipe in the hands-on laboratory.

Figure 3. Students in hands-on laboratory are reassembling a lawn mower engine.

To accomplish these goals a series of twelve two-hour laboratory experiences were developed based on the use of mechanical, electrical and technical skills. The laboratories included such topics as hand tools, power tools, electricity, metals, plumbing, small engines, automotives, and turbine engines.

The Career Counseling. The career counseling had three major goals: to define and explore various engineering disciplines, to identify the students' abilities and interests, and to integrate their understandings of the fields of engineering and their interests and abilities into a plan of action.

Three career planning sessions were scheduled. The first session was a lecture-discussion in which the interaction of interests, abilities, goals, and aspirations were discussed in relationship to career choice. The second session included

Figure 4. Christine D. Smith interprets the Strong-Campbell Interest Inventory for an Engineering 195 student during a career counseling session.

interpretations of the Strong-Campbell Interest Inventory and the Purdue Engineering Interest Questionnaire. In the final session students were given a final open-ended assignment in which they were asked to write their biographical introductions for a banquet in the year 1996 at which they were to be the principal speaker at age 50.

Student Journals. The students in Engineering 195 kept journals in which they gave their impressions of each lecture-discussion and each laboratory. The journals served two purposes. The main purpose of the journal was to help students become more aware of what their interests were in various fields of engineering and how they changed during the course. This made it helpful as part of the career counseling. Additionally, the journals gave the staff members valuable feedback on how the course was progressing, since the journals were collected periodically.

Testing for Evaluation Purposes. Seven standardized tests were used to assess knowledge in technical and mechanical areas. A survey was developed specifically for the project to measure experiences, interests, and attitudes; and a job interest questionnaire was used to measure changes in job interests. All of the cognitive tests were administered during the first two hour laboratory periods and again during the final laboratory period to both experimental and control subjects. The affective measures were given to subjects after the cognitive testing session to be taken home, completed and returned.

The standardized tests used for project evaluation were the Tool Knowledge Test (TKT), the Mechanical Information Test (MIT), the Electrical Information Test (EIT) from the Educational Testing Service; the Auto Mechanics Test (AMT), the Mechanics Test (MCT) from Science Research Associates; the Bennett Mechanical Comprehension Test (BMC) from the Psychological Corporation; the Purdue Mechanical Adaptability (PMA) and the Job Activity Preference Questionnaire (JAPQ) from the

Purdue Research Foundation.

Results

Cognitive Test Results. The cognitive pre-test and post-test results were compared in a 2x2 analysis of variance design in which sex and group (experimental or control) were the classification variables and the tests were the dependent variables. Table 3 summarizes the preliminary results. On every pre-test males had statistically significantly higher means than women at the .001 level; the experimental group had significantly higher mean scores at the .05 level on the Tool Knowledge Test only. Males still had statistically significant higher post-test means than women at the .001 level on all of the post-tests; the experimental group had significantly higher means on four of the six post-tests including the Purdue Mechanical Adaptability ($p < .05$), the Mechanical Information Test ($p < .001$), the Electrical Information Test ($p < .05$), and the Mechanics Test ($p < .05$).

Survey Results. The pre- and post-surveys included 150 items. Table 4 gives a selected set of items, percentages and group responses on the post-test. The first section contained a list of 17 goals of college education. Each goal was directly related to objectives of the experimental course. On the post-test students were asked how much they had achieved each goal during the semester. Each item on the survey was analyzed using a chi-square (χ^2) as the primary statistic. The experimental students were more likely to feel they had achieved each goal than the control group.

Other sections in the survey included: items about capability to do various hands-on types of activities (there were only a few significant differences and they were primarily sex differences); discussing, reading and participating in activities concerned with environment, energy, bio-medicine or productivity (experimental students were likely to have done so); and attitudes toward women in engineering.

Initially men had more confidence in their capability to do hands-on activities, but the post-test showed increased confidence of women in the experimental group to perform hands-on activities. Students in the experimental group participated in more organizational, problem-solving, and technical activities during the semester than did subjects in the control groups. There was very little change in the attitudes of the groups towards women in engineering. The women had very positive attitudes towards women in engineering; the men tended to have positive attitudes also, but they ranged from very positive to the very negative, and they were less likely to have very positive attitudes.

Student Journals and Write-In Comments. The student journals and write-in comments on the last page of the survey indicated that students in the experimental course generally enjoyed the course, that they would recommend the course to a friend, that they had learned from both the lecture-discussions and the hands-on laboratory and that they had

Table 3

Summary of Standard Score Means and Related Data on Pre- and Post-Tests of Experimental and Control Female and Male Participants in Purdue Experimental Course (T-Scores)

Pre-Test

Variable	Total $\bar{X}$	Total SD	Experimental F	Experimental M	Control F	Control M
PMA	50	10	44	55	43	53[1,4]
BMC	50	10	43	58	45	53[1,4]
TKT	50	10	42	60	40	55[1,4,9]
MIT	50	10	44	55	42	54[1,4]
EIT	50	10	44	54	42	54[1,4]
AMT	50	10	45	52	44	53[1,4]
MCT*	50	10	47	60	44	58[1,4]
(No. of Cases)	(129)		(37)	(14)	(14)	(64)

Post-Test

Variable	Total $\bar{X}$	Experimental F	Experimental M	Control F	Control M
PMA	53	49	61	47	55[1,4,9]
BMC	52	47	59	49	53[1,4]
TKT	52	46	62	44	55[1,4,8]
MIT	54	51	61	44	56[1,4,7]
EIT	53	50	58	45	56[1,4,9]
AMT	53	48	59	49	56[1,4]
MCT*	54	51	66	46	57[1,4,9]
(No. of Cases)	(129)	(37)	(14)	(14)	(64)

* Control groups smaller on MCT (Female = 10 and Male = 6)

PMA = Purdue Mechanical Adaptability Test
BMC = Bennett Mechanical Comprehension Test
TKT = Tool Knowledge Test
MIT = Mechanical Information Test
EIT = Electrical Information Test
AMT = Auto Mechanics Test
MCT = Mechanics Test

[1] $p < .001$ all groups
[2] $p < .01$ all groups
[3] $p < .05$ all groups
[4] $p < .001$ sex
[5] $p < .01$ sex
[6] $p < .05$ sex
[7] $p < .001$ experimental and control groups
[8] $p < .01$ experimental and control groups
[9] $p < .05$ experimental and control groups

Table 4

Percentage of Total and Male and Female Students in Experimental and Control Groups who Selected Various Response Categories for Sample of Post-Survey Items

	Percentages				
	Total	Experimental		Control	
	M+F	F	M	F	M
Goals Achieved During Past Semester "Very" or "Some"					
To develop an awareness of environmental problems and its relation to engineering	55	83	87	24	37***
To develop career plans	68	75	93	76	54*
To become familiar with hand tools	48	89	80	6	25****
To understand the basics of the internal combustion engine	41	72	80	6	19****
Self-Rating of Ability as "Superior" or "Considerable"					
Using visual displays (guages, dials, etc.)	52	39	87	23	60***
Setting up or adjusting equipment	41	29	67	18	50**
Read During the Past Semester About					
Bio-medical problems	48	91	73	18	21****
Productivity	45	69	60	18	35***
Women in Engineering "Agree" or ("Strongly Agree")					
Women have the capability to be successful engineers	90 (49)	100 (71)	87 (20)	94 (94)	83* (27)
To be a successful engineer, women do not have to sacrifice some of their feminity	73 (41)	89 (69)	66 (13)	94 (76)	58** (19)
Women in Engineering "Disagree" or ("Strongly Disagree")					
Women are less capable of learning mathematics and mechanical skills than men	89 (48)	100 (71)	86 (33)	94 (94)	81* (23)
Women are not competitive enough to be successful in the world of engineering	77 (40)	94 (63)	60 (13)	100 (82)	63* (19)

* p > .05
** p > .01
*** p > .001
**** p > .0001

generally come closer to making career decisions by participating in the course. Two interesting verbatim "introductions" by students of themselves at age 50 written as part of their last career planning assignment which they shared with the class reflect to a degree the tone, humor and spirit that the students had at the end of the course. They are as follows:

"Our next speaker is a rather remarkable human being. Graduating with a B.S. degree in Ind. Engr. from Purdue, she worked for a company while attending law school at night. Not satisfied with the law degree she sent back a few years later to get her master's in management. Through this she has been able to work her way up in the company and has extensively traveled and set top records in sales as well as giving many speeches world wide. She has been a member of the State and U.S. Congress for many years. Besides this she has raised a family, been a

Girl Scout Troop Leader, active in leading Youth Groups, plus an active member in her church as a section and lay minister. She has received numerous citations and awards, been on many important investigating and research and consultant committees, besides chairperson of the church rummage sale! Anyway, without further ado let me introduce Senator, lawyer, engineer, mother, and involved citizen, _____ _____." (Female Final Career Planning Assignment)

"Our next speaker is the man who probably make the greatest impact on our lives today. After graduating from Purdue in 1980 with a B.S. and M.S. in mechanical engineering and after working with Amalgamated Dynamics for 41 years, this man has many patents to credit his name, some of the major ones being the automatic bicycle transmission, the role compensator for autos, and the solar powered air-conditioner. Without further ado here is _____ _____." (Male Final Career Planning Assignment)

Table 5 contains selected write-in comments from the journals and final survey.

Discussion

Although the preliminary cognitive test results show that the course was not successful in completely eliminating sex differences in knowledge of mechanical and technical areas, the results did show that the experimental group gained in technical and mechanical knowledge over the control group, and this gain was statistically significant. The survey showed affective gains for subjects in the experimental group in participation in professional, achievement of goals, and increased confidence.

Considering the test results and journals comments, the staff felt that the project was successful, but hopes to revise and improve the model program before issuing a final report. Plans for revision include: expanding the career counseling materials and activities and focusing on more individual counseling to meet the particular needs of the students, revising the laboratories so that they are more related to the lecture-discussions and include more engineering related activities, and increasing the diversity of the role model speakers chosen.

Long range plans tentatively lean towards dividing the three areas of emphasis (lecture-discussions, hands-on laboratories and career counseling) into mini-courses and integrating the courses into the freshman engineering program in order to further meet the needs of individual students who enter freshman engineering programs.

Dissemination of the results of the project are being planned through an invitational workshop tentatively scheduled for December 1-2, 1977, at Purdue University. Professional papers and publications, print and non-print media and a final report to be distributed to U.S. engineering institutions will provide additional dissemination.

Table 5

Selected Write-In Comments from Student Journals and Post Survey

Role Model Lecture-Discussions

Two environmental engineers talked to us about their jobs. Both were very interesting. I think that environmental engineering might be what I want to do as their jobs sounded fascinating, and I am concerned about the environment. (Female Journal)

Professor Amrine drew my attention really well because he not only talked about productivity but gave us a problem in productivity and our prospective engineering minds had to get the job done more efficiently. He made good points and the pegboard re-emphasized his points. (Female Journal)

Definitely provided the overall picture of engineering relationships. (Female Final Survey)

Hands-On Laboratory

Can an extension cord I make be trusted? You all seem to think so. I know it was fun. Sometimes I can't believe the things we do in these labs. My father will be amazed at me. I won't mind helping him fix things anymore because I've soldered and drilled and stripped wires too, and now I really know I can do it. It's a lot less of an obstacle now. Each lab helps me to try new things I've always avoided. (Female Journal)

I loved this lab. I really enjoy working with the machinery and seeing how the machinery operates. I can't believe how much more effective "doing" is than reading or listening. I think it's a lot of fun making things with the tools. (Female Journal)

It reminded me of my 8th and 9th grade shop classes, though it was better than taking a test. I do enjoy working with my hands and seeing the finished product. (Male Journal)

I enjoyed the laboratories more than anything else in the class. They were both challenging and exciting. (Female Final Survey)

Career Planning

This is really making me think! I never considered career planning a process before. Worse, I don't like to think about goals changing as our interests change. (Female Journal)

The career planning, particularly the review of the Strong-Campbell Interest Survey results, was helpful. (Female Final Survey)

Summary

Purdue's Freshman Engineering staff developed a model program designed to meet the special needs of women entering engineering. An experimental course open to freshmen and women was developed with three areas of emphasis: (1) lecture-

discussions by various role models on engineering related societal problems of environment, energy, transportation, bio-medicine and productivity; (2) hands-on laboratory experiences; and (3) career planning sessions.

Pre- and post-cognitive testing and surveys indicate significant positive results on most cognitive and affective measures with greater gains for those participating in the experimental course than those in a control group. Future plans call for some revisions in the model programs directed at enhancing the engineering relevance and flexibility to meet individual needs. The results of the project will be disseminated through a workshop and general and professional reports.

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Co-Principal Investigators for Purdue's model program under a Women's Educational Equity Act grant (left to right): Smith, Blalock, Knigga, LeBold, Butler, and Heckert.

Christine D. Smith is Coordinator for Purdue's Program for Women in Engineering and is the Faculty Advisor to the Society of Women Engineers. She has a B.A. in Sociology from Tulane and an M.S. in Counseling and Personnel Services from Purdue. Her primary responsibility was for the career planning phase of the model program.

Marion Blalock is Coordinator of Purdue's Freshman Minority Engineering Programs. She has a B.S. in Sociology and an M.S. in Counseling and Personnel Services from Purdue. Her responsibilities include career counseling and test interpretation in the model program.

E. Marie Knigga is Assistant Director of Pre-Engineering Programs in the Freshman Engineering Department at Purdue. She received her B.S. and M.S. degrees in Home Economics from Purdue. She had responsibility for coordinating the role model lecture-discussions in the model program.

William K. LeBold is Director of Engineering Education Research Studies at Purdue and Editor of the 1977 Annals of Engineering Education. He was Project Director and responsible for the design and evaluation of the model program.

Blaine R. Butler, Associate Professor of Aeronautical Engineering, is responsible for Purdue's Freshman Honors Program and has received Purdue awards for his outstanding counseling. He has a B.S. from the U.S. Military Academy and an M.S. and Ph.D. in Aeronautical Engineering from Purdue. He was responsible for coordinating the experimental course and the laboratory in the model program.

Bonnie L. Heckert is a Research Assistant in Engineering Education Research Studies at Purdue University. She received a B.S. in Education from The Ohio State University and is currently working towards an M.S. in Educational Psychology at Purdue. Her primary concern was the evaluation of the model program.